Search for the Jacobi shape transition in rapidly rotating nuclei: 2. Interpretation

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The signature of a nucleus rotating in a Jacobi-like configuration is the decrease of rotational frequency with increasing spin. This expectation is based on the rather universal rapid increases in a fluid's elongation, caused by the centrifugal force, once the Jacobi regime has been reached. In nuclei, the frequency of collective rotation is directly related to the E2 gamma-ray energy by $\hbar\omega \approx E_\gamma/2$. The Jacobi signature is then a decrease of E_γ with increasing spin. Part 1 of this report (preceding) shows how the energy of collective transitions can be determined, and these results are summarised in Fig. 1.

In a liquid-drop model, as well as in the more realistic semi-classical Thomas-Fermi nuclear model generalised by the addition of a centrifugal term, the transition from oblate to triaxial (Jacobi) shapes takes place abruptly, in a change akin to a phase transition associated with the breaking of axial symmetry. In nuclei, collective rotations about a symmetry axis are suppressed, so that even below the Jacobi regime, collective rotations are not about an axis of symmetry, [1] and the abrupt phase transition will be smoothed out. We have accordingly modified the Thomas-Fermi model by a smooth interpolation between the low angular momentum predictions (with an empirical allowance for pairing effects) and the high angular momentum (Jacobi) regime where the unmodified calculations are likely to be adequate[1]. The results are shown in Fig. 1. They suggest that at the highest angular momenta observed we are on the verge of entering the Jacobi regime.[2]

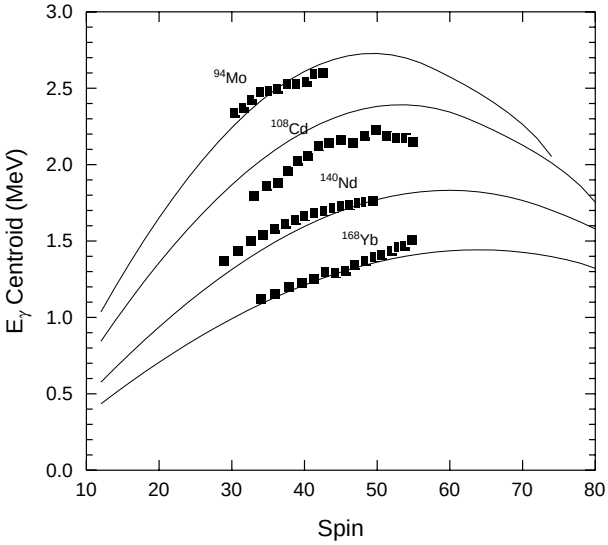

Figure 1: Points show the measured centroid of the E2 bump in the incremental spectra i.e., the spectra of (new) transitions feeding in at the highest spins, and isolated by subtracting results for gating on adjacent K-values (cf. part 1 preceding). The continuous curves are derived from a Thomas-Fermi model modified to smooth out the the sharpness of the Jacobi transition.

References

[1] W.D.Myers and W.J.Swiatecki, Acta Physica Polonica, to appear 2001;also //ftp:www-nsdth.lbl.gov/pub/myers/zak20

Footnotes and References

[1] The incremental E2 bump does not account for the total (incremental) gamma-ray flux, and there probably are oblate non-collective structures at the highest spins which compete with the collective prolate states.

Footnotes and References

[2] Some of the increases in the nuclear moment of inertia may be due to Coriolis effects whereby individual nucleonic orbits are aligned to the rotation axis.